FOREST HEALTH PROTECTION
South Sierra Shared Service Area
19777 Greenley Road Sonora, CA

Report No. SS08-05

August 18th, 2008
File No. 3420

To: Diane Rubiaco, District Ranger, Pacific Ranger District, Eldorado National Forest

Subject: Evaluation of Dwarf Mistletoe Infection for Poison Hole Project

At the request of Don Errington, Timber Management Officer, Pacific Ranger District, we conducted a field evaluation in the Poison Hole project area on the Pacific RD, Eldorado National Forest, on July 14th, 2008. The objective was to evaluate forest conditions and provide management recommendations to enhance tree health in red fir plantations and surrounding stands.

Background

A shelterwood cut occurred in the late 1980s that led to ≈ 60 acres of regenerated red fir (*Abies magnifica*) in six discontinuous units (Appendix A). Red fir stocking currently exceeds 1000 trees/acre and consists of saplings primarily 4 in. diameter breast height (dbh) (range 2-6 in.) and 6 ft (range 2-20 ft.) in height (Figure 1). Management objectives for plantations in the 2004 Sierra Nevada Forest Plan Amendment (p. 49-50) are to "accelerate the development of key habitat and old forest characteristics" and "reduce risk of loss to wildland fire". Specific management objectives for these plantations are to promote maximal growth rates and minimize dwarf mistletoe infection to enable the regenerated stands to attain "old growth" characteristics in ≈ 100-110 years. Pacific RD staff proposed a goods-for-services contract for a sanitation thinning to remove overstory trees infected with dwarf mistletoe. Revenue from the thinning, combined with Christmas tree sales, is planned to finance subsequent pre-commercial thinning of the plantation trees.

Figure 1. Typical height of red fir regeneration.

Observations

Seed trees were not harvested in four of the six units. These trees, as well as overstory trees in the perimeter surrounding the regeneration, were generally unhealthy red fir infected with red fir dwarf mistletoe (*Arceuthobium abietinum* f. sp. *magnificae*) (DM) and cytospora cankers (*Cytospora abietis*) (Figures 2 & 3). Lodgepole pine (*Pinus contorta*), western white pine (*Pinus monticola*), Jeffrey pine (*Pinus jeffreyi*) and incense cedar (*Calocedrus decurrens*) are also present in the perimeter stands.

Approximately 5 fir seed trees/acre were retained with the majority (80%) being larger (35 – 50 in. dbh) trees and the remaining were smaller (15 – 20 in. dbh) trees. Approximately 50% of the large seed trees and 100% of the small seed trees have severe DM infection (ratings from 4-6) based on the Hawksworth DM rating system (Hawksworth and Weins 1996).

Basal area in the perimeter stands ranges from 200-325 ft^2/acre with 30 in. average dbh (range 8-40 in.) trees. Species composition was either dominated by (≥ 80%) or comprised of <50% red fir. In areas dominated by red fir, ≈ 90% of the 60-75 trees/acre of mature fir had severe DM branch infections (DM rating 4-6) with cytospora cankers and/or DM bole infections (Figures 2 & 3). In the stands that had a higher component of other conifer species, the red fir had low to moderate DM infections (DM rating 1-3) and fewer cytospora cankers.

Figures 2 & 3. Red fir regeneration surrounded by overstory seed and perimeter trees infected with DM and cytospora cankers.

Recent red fir mortality (≈ 2-3 trees/acre) in the perimeter stands occurred over the past few years. Trees that died many years ago had evidence of attack by roundheaded fir borers (*Tetropium abietis*) and fir engraver (*Scolytus ventralis*). Although not visible from the ground, trees that died recently likely had successful fir engraver attacks higher on the bole. Top-kill, likely caused by fir engraver attack, was also observed on ≈ 1 tree/acre.

Approximately 2-5 trees/acre of the regeneration, all located in close proximity to the drip line of the overstory trees, had light DM infection (DM rating 1) in branches and no visible stem infections (Figure 4). Approximately 1 tree/unit in the plantation trees had severe DM branch infections (DM rating 5 or 6), DM bole infections and cytospora cankers. DM shoots normally take 2-3 years post-germination to become visible on infected hosts (Filip 2000). Thus, it is likely that additional understory red fir have asymptomatic infections that will produce DM shoots in subsequent years.

Figure 4. Red fir sapling infected with DM and cytospora cankers.

Management Options

DM is an obligate parasite that can only reproduce in live host tissue (Filip 2000). Treating infected trees or branches can remove the source of DM inoculation. Red fir DM rarely infects other tree species so treatments need only target red fir. DM can intensify within a host tree through seed dispersal and/or vegetative growth of the DM plant. Infections can spread to uninfected hosts as DM seeds are discharged aerially (Geils et al. 2002). Seeds can shoot 50 ft. away from parent plants and further distances can be obtained when seeds are windblown. However, new infections usually occur within 15 ft. of seed source. The average rate of spread for DM is 2-3 ft. per year in single-storied stands but spread rates are greatly increased in multi-storied stands as seeds fall on lower canopy layers (Filip 2000).

No Action

DM seeds from the overstory trees are infecting the regenerated fir. Without intervention, further infection of the regeneration is likely and could eventually yield dense stands of unhealthy, slow growing trees with severe DM infections. Mature trees heavily infected with DM exhibit decreased growth and are more susceptible to cytospora infection, fir engraver,

and/or roundheaded fir borer attack (Table 1) (Ferrell 1986; Wood et al. 2003). Heavily infected branches and stems have reduced water potential and carbon accumulation rates (Knutson 1983). During extended periods of below average precipitation, these conditions alone can cause tree mortality. Mortality of ≈ 30% of the severely infected seed and perimeter fir trees should be anticipated within 20 years (see Table 1).

Table 1 Expected Growth Potential Reduction and Mortality Rates in True Fir Infected with DM

	Hawksworth DM Infection Rating						
	0	1	2	3	4	5	6
Ten Year Diameter Growth Potential Reduction (%)	0.0	0.0	0.0	2.0	5.0	30.0	50.0
Ten Year Mortality (%) in Trees < 9" dbh	0.0	0.8	2.8	6.1	10.5	16.2	23.1
Ten Year Mortality (%) in Trees > 9" dbh	0.0	0.7	2.3	5.0	8.8	13.5	19.2

Data derived from: Hawksworth, F.G. et al. 1992. Interim dwarf mistletoe impact modeling system: User's guide and reference manual. Report MAG-91-3. USDA Forest Service, Methods Application Group, Fort Collins, CO. 90 p.

Treatment Alternative for Regeneration

The plantation trees should be thinned to increase growth and vigor and reduce future susceptibility to fir engraver attack. Thinning prescriptions should target trees with DM branch or bole infections and/or cytospora cankers for removal. Residual basal area should be appropriate for the site conditions while considering the number of years until the next planned entry.

Treatment Alternatives for Seed and Perimeter Trees

Below are three management alternatives for treating the DM-infected overstory fir to protect the regeneration (Figure 5). Each alternative has tradeoffs regarding the temporal efficacy and degree of DM mitigation. Treatments options include felling trees, pruning branches, girdling trees or branches, or chemically thinning trees. Since many of the mature trees have stem infections, treating the entire tree, rather than pruning or girdling branches, is recommended.

Alternative 1

Treat all DM-infected overstory seed and perimeter trees within 15 ft. of the regeneration. This will create a buffer zone to reduce the occurrence of new infections. However, seed sources in the perimeter trees would remain and moderate to severe infections (DM ratings 3-6) of the regeneration can be expected in 20-30 years, particularly along the perimeter. Perimeter trees beyond 15 ft. of the regeneration would not be treated.

Alternative 2

Treat all DM-infected overstory seed and perimeter trees within 15 ft. of the regeneration and all infected perimeter trees within a variable distance of 3 ft. for each year to the next planned entry. For example if the next entry is planned in 20 years, infected trees within 60 ft. of the buffer zone (20 years * 3 ft./year) would be treated. Light to moderate infection may occur in the regeneration over the subsequent 20-30 years. Infected trees should be targeted for removal during the next entry.

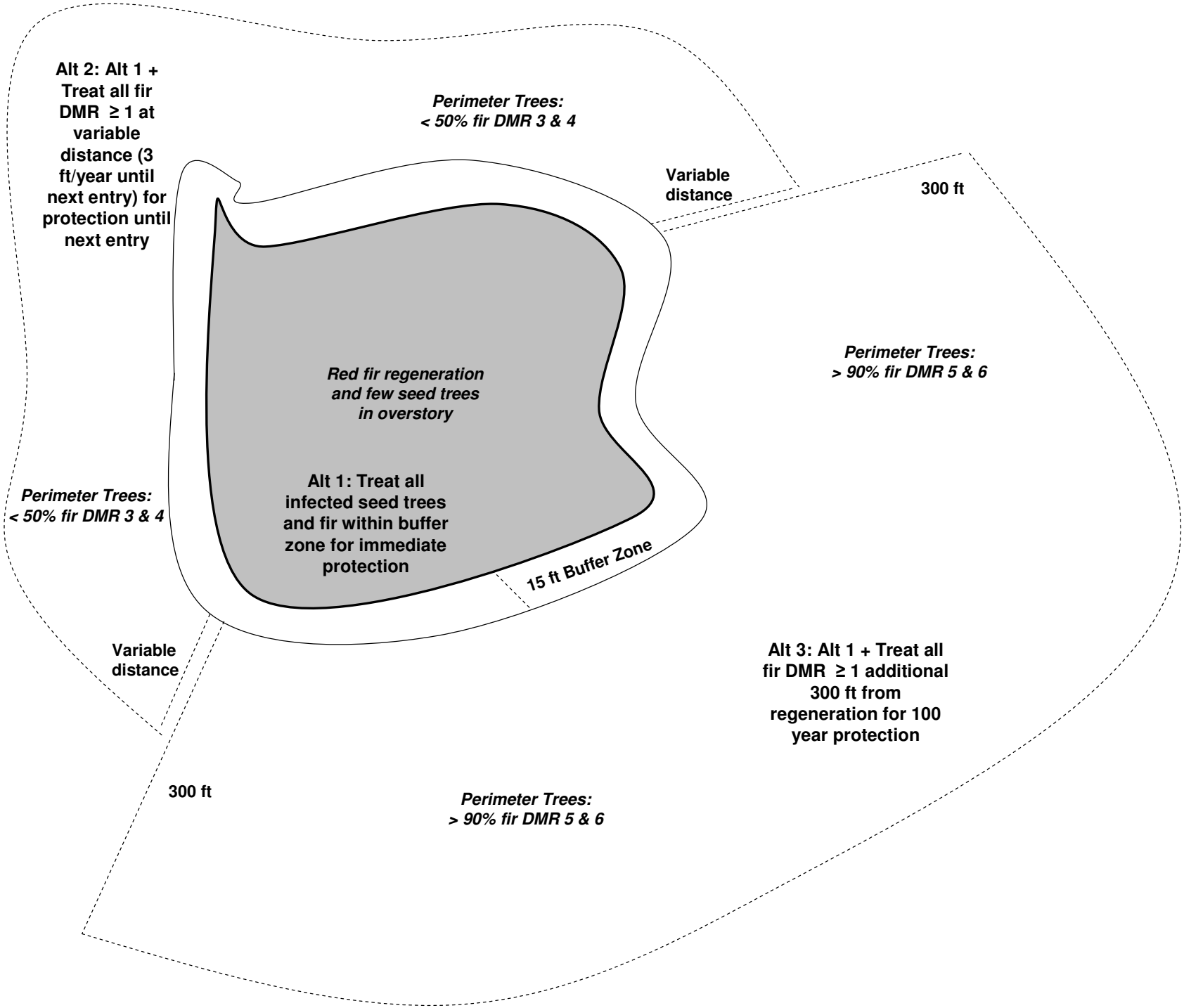

Figure 5. Schematic diagram depicting alternatives to mitigate DM infection for Poison Hole Project, Pacific Ranger District, Eldorado NF.

Alternative 3

Treat all DM-infected overstory seed and perimeter trees within 15 ft. of the regeneration and any infected perimeter tree within 300 ft. of the buffer zone. Assuming a 3 ft./year spread rate for DM from overstory trees surrounding the regeneration, this alternative should provide protection for ≈ 100 years or until the stands are close to attaining "old growth" characteristics.

Based on previously described management objectives for the red fir plantations, Alternative 2 or 3 should be considered where species composition is primarily red fir and the DM infection is heavy. Alternative 2 should be considered in areas where there is less red fir and DM infection is light to moderate.

It is often difficult to detect light levels of DM infection in tall trees, therefore overstory trees should be assumed to have DM if understory trees within their drip lines are infected. In addition, as cytospora cankers are often associated with DM, the resulting branch mortality caused by the cankers can be used to identify infected trees.

Feel free to contact us with additional questions. We are available to provide DM identification training or respond to other forest insect or disease-related concerns.

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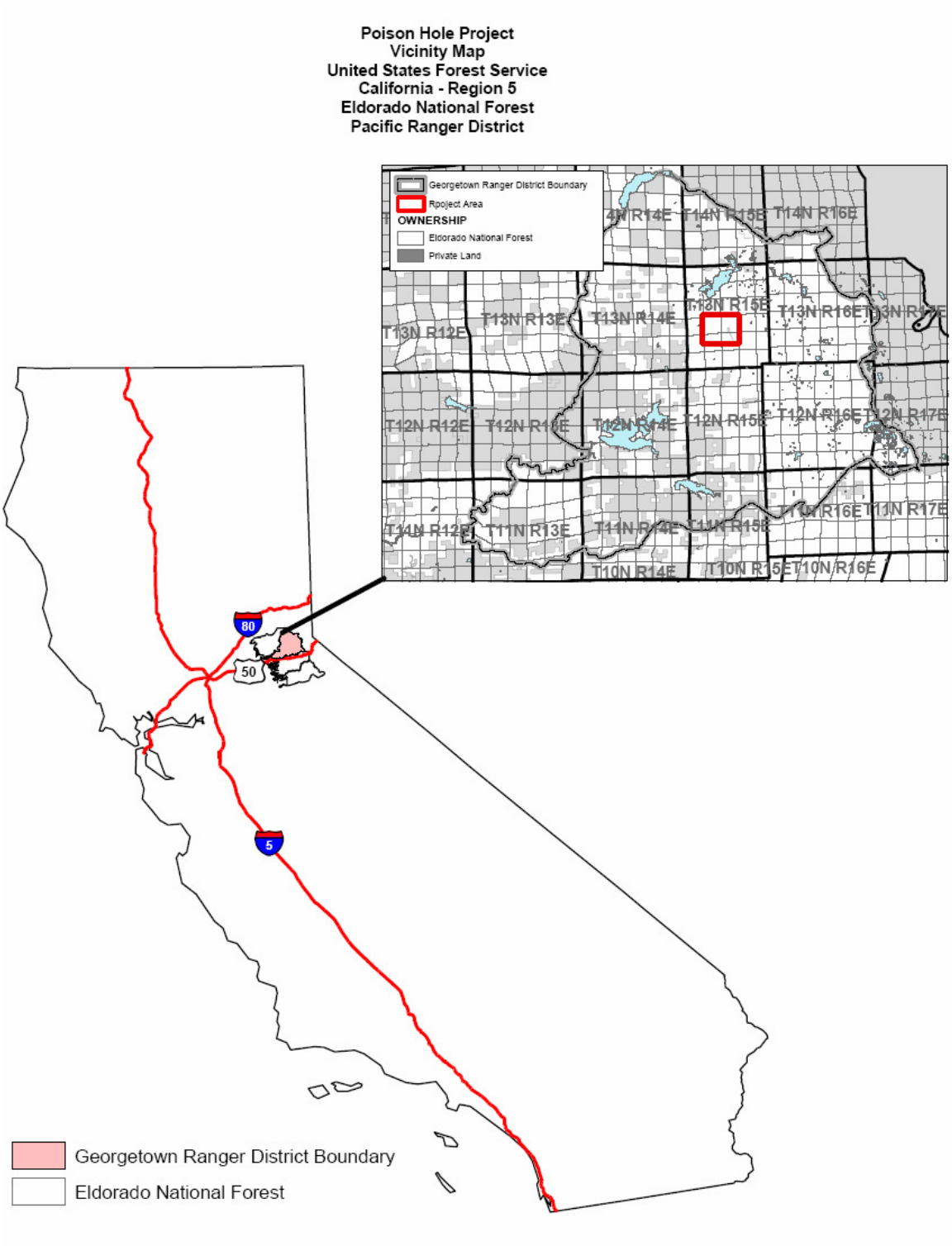
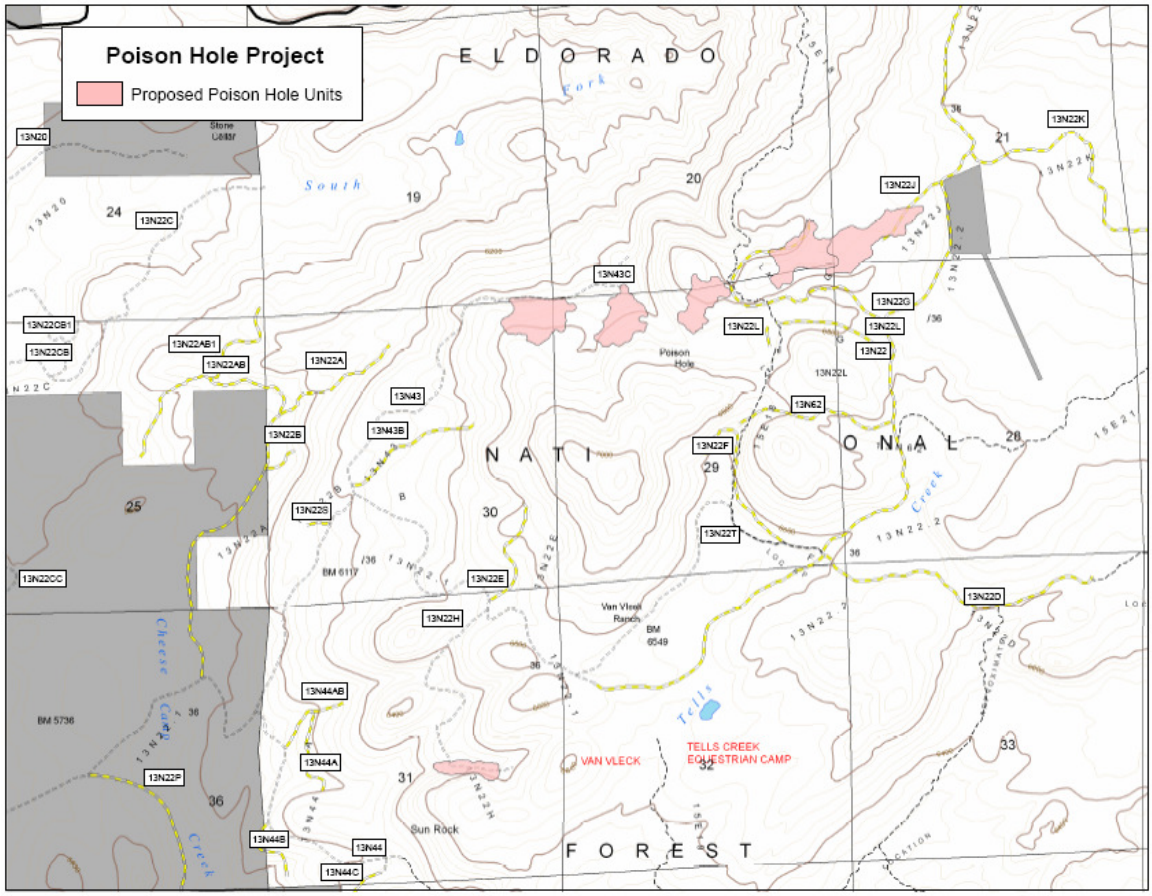
Appendix A Maps of proposed Poison Hole Project area locations courtesy of Don Errington.




Poison Hole Project
Proposed Poison Hole Units
E L D O R A D O
N A T I O N A L
F O R E S T
South Fork
Poison Hole
Creek
Van Vleck Ranch
BM 6549
BM 5736
BM 6117
VAN VLECK
TELLS CREEK EQUESTRIAN CAMP
Sun Rock
13N20
13N22C
13N22CB1
13N22CB
13N22AB1
13N22AB
13N22A
13N22B
13N22BB
13N22CC
13N22E
13N22H
13N44AB
13N44A
13N44B
13N44
13N44C
13N22F
13N43
13N43B
13N43C
13N22L
13N22G
13N22J
13N22K
13N22
13N62
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